Int. J. Adv. Res. Sci. Technol. Volume 4, Issue 3, 2015, pp.374-377.

IJARST

International Journal of Advanced Research in Science and Technology

journal homepage: www.ijarst.com

ISSN 2319 – 1783 (Print)

ISSN 2320 – 1126 (Online)

Taguchi's Optimization of Process Parameters Using CNC End Milling Machine

Haripriyani. A and D. Santha rao*

Department of Mechanical Engineering, BVC College of Engineering, Odalarevu, India.

****Corresponding Author's E-mail*: *arava.haripriyani@gmail.com***

ARTICLEINFO

Article history:

Received	21 Apr. 2015
Accepted	12 May 2015
Available online	14 May 2015

Keywords:
Surface roughness,
Aluminum metal matrix,
Orthogonal array,
ANOVA,
Regression analysis.

ABSTRACT

In this study an attempt has been made to manufacture the Aluminum metal matrix (AMC) through a liquid metallurgical route. The matrix used in the study is Aluminum cast alloy 64430 and reinforcement particles selected are Silicon Carbide (SiC) particles ranging its size from 50-70 microns. Application of these materials in many areas is due to its light weight, good wear resistance and machinability. End milling is one of the most commonly used metal removal operation in industry because of its ability to remove material faster with good surface finish. The parameters that influence the surface roughness are spindle speed, depth of cut, feed rate, material and geometry of tool. The study also focuses to Optimize process parameters using Taguchi design of experiments. The three process parameters and three levels are selected and orthogonal array L9 is used for experimentation and the surface roughness is measured and optimized. Analysis of variance (ANOVA) is performed to know the impact of individual factors on surface roughness and material removal rate. Using regression analysis the theoretical values are predicted and compared with the experimental values for validation.

Introduction:

In present time the technology of CNC vertical milling machine has been improved significantly to meet the advance requirements in various manufacturing fields, especially in the precision metal cutting industry. This experiment gives the effect of different machining parameters (spindle speed, feed, and depth of cut) on surface roughness in end milling. The demand for high quality and fully automated production focus attention on the surface condition of the product, surface finish of the machined surface is most important due to its effect on product appearance, function, and reliability. For these reasons it is important to maintain consistent tolerances and surface finish. Among several CNC industrial machining processes, milling is a fundamental machining operation. End milling is the most common metal removal operation encountered. It is widely used in a variety of manufacturing in industries. The quality of the surface plays a very important role in the performance of milling as a good-quality milled surface significantly improves fatigue strength, corrosion resistance, or creep life. The surface generated during milling is affected by different factors such as vibration, spindle run–out, temperature, tool geometry, feed, cross-feed, tool path and other parameters. During finish milling, the depth of cut is small. Technological parameter range plays a very important role on surface roughness. In end milling, use of high cutting speed, low feed rate and low depth of cut are recommended to obtained better surface finish for the specific test range in a specified material. This experimental investigation outlines the Taguchi optimization methodology, which is applied to optimize surface roughness in end milling operation. made to manufacture the AMC through a liquid metallurgical route. The matrix used in the study is Aluminum cast alloy 64430 and reinforcement particles selected are Silicon Carbide (SiC). The experiment is conducted on AMC'S the processing of the job is done by High Speed Steel (HSS) end-mill tool under finishing conditions. The machining parameters evaluated are spindle speed, feed rate and depth of cut. The experiments are conducted by using Taguchi L9 orthogonal array as suggested by Taguchi. Signal-to-Noise (S/N) ratio and Analysis of Variance (ANOVA) is employed to analyze the effect of milling parameters on surface roughness.

Literature survey:

A series of experiment have been carried out in Design of Experiments to investigate the influence of cutting parameters such as cutting speed, feed rate and depth of cut on surface roughness in face milling operation. [2] Taguchi parameter design which provides a systematic procedure that can effectively and efficiently identify the optimum surface roughness in the process control of individual end milling machines. [4] A series of experiment have been carried out in Design of Experiments to investigate the influence of cutting conditions such as cutting speed, feed rate per tooth, feed velocity on tool life, tool wear and surface finish in face milling operation. [5] Investigated the machining parameters such as number of passes, depth of cut in each pass, spindle speed and feed rate to get better surface finish, dimensional accuracy and tool wear.

Taguchi technique:

Taguchi proposes a holistic view on quality, which relates quality to cost, not just to the manufacturer at the time of production, but to the customer and society as a whole. Taguchi defines quality as, "The quality of a product is the (minimum) loss imparted by the product to the society from the time product is shipped" .This economic loss is associated with losses due to rework, waste of resources during manufacture, warranty costs, customer complaints and dissatisfaction, time and money spent by customers on failing products, and eventual loss of market share. Robust design is an engineering methodology for obtaining product and process conditions, which are minimally sensitive to the various causes of variation to produce high quality products with low manufacturing costs. Taguchi's parameter design is an important tool for robust design. It offers simple and systematic approach to optimize design for performance, quality and cost. Two major tools in robust design are orthogonal arrays, which accommodate many design factors simultaneously

The signal-to-noise ratios of each experimental run are calculated based on the following equation, which are listed in corresponding tables with the data. The equation is

$$S/N = -10 \text{ Log}_{10} [\Sigma y^2 / n] \quad - (1)$$

Where S/N is the signal to noise ratio of i^{th} term, n = number of measurements in a trial/row, in this case n=3 and Yi is i^{th} the measured value in a run/row

Experimentation:

Experiment and Data Collection:

Experiments are designed with the help of using Taguchi L9 orthogonal array. The software used for DOE (Design of experiment) is Minitab15.

Table: 1. Process parameters and their levels

Factors	Level(1)	Level(2)	Level(3)
Spindle speed(rpm)	5000	6000	7000
Depth of cut(mm)	0.2	0.5	1.0
Feed rate(mm/min)	100	200	300

Design of experiments (DOE):

For selected input parameters experiments are designed using Taguchi L9 orthogonal standard array. For this purpose software Minitab 17 is used

Table: 2. L9 Orthogonal array (3^2)

S. No	Spindle speed (rpm)	Depth of cut(mm)	Feed rate (mm/min)
1	5000	0.2	100
2	5000	0.5	200
3	5000	1.0	300
4	6000	0.2	200
5	6000	0.5	300
6	6000	1.0	100
7	7000	0.2	300
8	7000	0.5	100
9	7000	1.0	200

Work piece material:

The material selected are Metal matrix composite of aluminum. The test specimens are cast into 100*100*12 size, to accommodate 9 experiments machining in a piece. Specimen are rough machined all faces to get flat surface. The thickness is maintained 12mm to ensure rigidity of mounted piece on the machine table

Figure: 1. Machine

Figure: 2. Closer view

Experimentation:

After DOE, 9 experiments are carried out in CNC vertical End milling. After each experiment Ra is calculated. A quality characteristic for Ra is smaller is the better. The roughness readings were taken in random order to average out effects of uncontrolled variables which could be present in the experiment. Ra values were repeated at least 3 times and then average of these values was recorded

Table: 3. Surface roughness and MRR values of Aluminum-64430 with 5%Sic

Exp.	Spindle speed (rpm)	Depth of cut (mm)	Feed rate (mm/min)	Ra (avg) (μm)
1	5000	0.2	100	0.72
2	5000	0.5	200	0.80
3	5000	1.0	300	0.98
4	6000	0.2	200	0.75
5	6000	0.5	300	0.92
6	6000	1.0	100	0.70
7	7000	0.2	300	0.87
8	7000	0.5	100	0.59
9	7000	1.0	200	0.79

Results and Discussion:

Selection of optimum level of surface roughness:

For optimization of surface roughness, S/N ratio is selected and considered with "Smaller-the-Better" option. Minitab assigned ranks based on delta value for surface roughness is shown in the table 5.2.From the response table it can be seen that rank of spindle speed is high compared to feed rate and depth of cut. This indicates that the effect of spindle speed is high followed by feed rate and depth of cut.

Table: 4. Response table of signal to noise ratio for Ra

Level	Spindle speed	Depth of cut	Feed rate
1	1.6557	2.1872	3.5114
2	2.1070	2.4151	2.1615
3	2.6133	1.7737	10.7031
Delta	0.9577	0.6415	2.8033
Rank	2	3	1

The optimum parameters obtained from the levels is given in the below

Table: 5. Minimum value obtained for Ra

Exp. No	Spindle speed, s (rpm)	Depth of cut, d (mm)	Feed rate, (mm/min)	Surface roughness Ra(μm)
6	7000	0.5	100	0.59

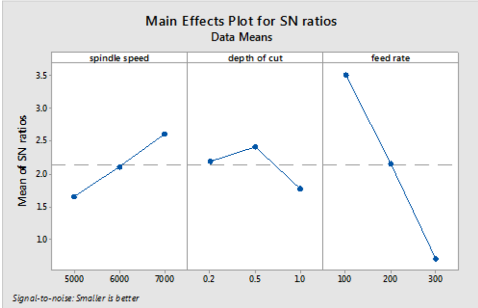

Figure: 3. Main effect plots for SN ratio means of Surface roughness

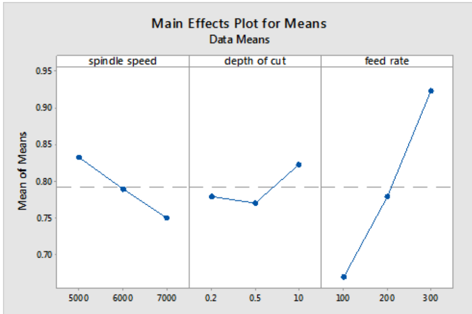

Figure: 4. Main effect plots for means of Surface Roughness

ANOVA for surface roughness:

In order to investigate the significant parameter, Analysis of Variance (ANOVA) is performed using MINITAB software. It is done with the experimental data of surface roughness results.

Table: 6. ANOVA Table for surface roughness

Source	DF	Seq SS	Adj MS	F	%
Spindle speed	2	0.010422	0.005211	5.15	9.14
Depth of cut	2	0.004822	0.002411	2.38	4.23
Feed rate	2	0.096822	0.048411	47.88	84.87
Error	2	0.002022	0.001011		1.76
Total	8	0.114089			100

Regression analysis:

The correlate the factors such as spindle speed, depth of cut, feed rate and responses such as surface roughness of CNC End milling machine of AMC IS-64430 are obtained by multiple linear regression.

The regression equation for surface roughness is

Ra =0.7540-0.000042 spindle speed + 0.0595 depth of cut + 0.001267 feed rate

Table: 7. Summary of regression analysis for Alloy

S value	R-Sq (%)	R-Sq(adj)
0.0280476	96.55	92.48

Conclusions:

1. Taguchi method is applied successfully in order to identify optimum values of Surface roughness. Based on the analysis it is identified that the minimum value of surface roughness is obtained at spindle speed of 7000rpm, depth of cut 0.5mm and feed rate of 300mm/min.
2. Based on ANOVA results of surface roughness it can be observed that the feed rate 84.87(%) has high influence the surface roughness, whereas depth of cut 4.23(%) and spindle speed 9.14(%) had less influence when compared to feed rate.
3. Regression model developed in this investigation could be used for real time prediction for surface roughness.

References:

1. N. Suresh Kumar Reddy and P.Venkateswara Rao "Selection of Optimum Tool Geometry and Cutting Conditions using a Surface Roughness Predction Model for End Milling".
2. Sanjit Moshat,Saurav Datta,Asish Bandyo Padhyay and Pradeep Kumar Pal "Optimization of CNC End Milling Process Parameters using PCA based Taguchi Method.
3. Yanming Liu and Chaojun Wang , " Neural Network based Adaptive Control and Optimization in the Milling Process"
4. H.Oktem "An Integrated Study of Surface Roughness for Modeling and Optimization of Cutting Parameters during End Milling Operation"
5. E.Kuram B.T.Simsek,B.Ozcelik,E.Demirbas and S.Askin " Optimization of the Cutting Fluids and Parameters using Taguchi and ANOVA in Milling ".

About Authors:

A. HARI PRIYANI is a P.G student of Mechanical Department of BVC College of engineering. She done her B.Tech from ASR college of Engineering affiliated to Andhra University.

D.SANTHA RAO M.Tech (Ph.D) is presently Associate Professor in BVC college of Engineering. He has vast experience in the field of teaching. He has guided many projects for B.Tech & M.Tech Students.